IBM 1401 Data Processing System
Reference Card

INSTRUCTION FORMAT

The IBM 1401 Data Processing System uses a variable word-length concept; the length of an instruction can vary from one to eight characters.

OP CODE	A- or I-ADDRESS	B-ADDRESS	d-CHARACTER
X	XXX	XXX	X

Op Code: This is always a single character which defines the basic operation being performed. A word mark is always associated with the operation code position of an instruction.

A-Address: This always consists of three characters. It can identify the units position of the A-field, or it can be used to select a special unit or feature (tape unit, column binary feature, disk storage, inquiry, etc.).

I-Address: Instructions that can cause program branches use the I-address to specify the location of the next instruction to be executed if a branch occurs.

B-Address: This is a three-character storage address associated with the B-field. It usually addresses the units position of the B-field, but in some operations, such as tape or disk record read and write, it specifies the high-order position of a record storage area.

d-Character: The d-character is used to modify an operation code. It is a single alphabetic, numerical, or special character, positioned as the last character of an instruction. It can be used with instructions of any length.

PROCESSING OVERLAP

A-Address

The hundreds position of the A-address of a tape or input-output unit (not 1405 or 1407) instruction is changed from % to @. The symbol is used to signal an overlap operation with character reader, magnetic tape, paper tape, and data transmission units.

Overlap Mode

The following instructions are used when the system is in the overlap mode and card, printer or serial I/O operations are to be performed.

INSTRUCTION	FUNCTION
K$	Overlap On
K(I)$	Overlap On And Branch
K●	Overlap Off
K(I)●	Overlap Off And Branch
K☐	Reset Overlap
K(I)☐	Reset Overlap and Branch

1405 TIMING

	MAX.	AVG.	MIN.
Disk to Disk	800 ms	600 ms	450 ms
Track to Track	250 ms	175 ms	100 ms
Record to Record, same Track	50 ms	25 ms	

SYSTEM TIMINGS

OPERATION	OP CODE	FORMULA
Punch a Card	4	$.0115 (L_I + 1) + I/O$
Read a Card	1	$.0115 (L_I + 1) + I/O$
Read and Punch	5	$.0115 (L_I + 1) + I/O$
Select Stacker	K	$.0115 (L_I + 1)$
Set Word Mark	,	$.0115 (L_I + 3)$
Start Punch Feed*	9	$.0115 (L_I + 1)$
Start Read Feed*	8	$.0115 (L_I + 1)$
Store A-address Register*	Q	$.0115 (L_I + 5)$
Store B-address Register*	H	$.0115 (L_I + 4)$
Subtract (no recomplement)	S	$.0115 (L_I + 3 + L_A + L_B)$
Subtract (recomplement)	S	$.0115 (L_I + 3 + L_A + 4 L_B)$
Write a Line	2	$.0115 (L_I + 1) + I/O$
Write and Punch	6	$.0115 (L_I + 1) + I/O$
Write and Read	3	$.0115 (L_I + 1) + I/O$
Write, Read and Punch	7	$.0115 (L_I + 1) + I/O$
Zero and Add	?	$.0115 (L_I + 1 + L_A + L_B)$
Zero and Subtract	!	$.0115 (L_I + 1 + L_A + L_B)$

TAPE OPERATIONS

T_m — Tape movement can be determined from the following:

1 = Number of Characters
C = Character Rate

729 II at 200 cpi	= .067 ms			
at 556 cpi	= .024 ms			
at 800 cpi	= .017 ms			
729 IV at 200 cpi	= .044 ms			
at 556 cpi	= .016 ms			
7330 at 200 cpi	= .139 ms			
at 556 cpi	= .050 ms			

729 Model II and V Read 10.7 + CN ms	= TAU interlocked
10.5 + CN ms	= Processing interlocked
Write 11.7 + CN ms	= TAU interlocked
7.5 + CN ms	= Processing interlocked
729 Model IV, Read 6.8 + CN ms	= TAU interlocked
6.7 + CN ms	= Processing interlocked
Write 7.8 + CN ms	= TAU interlocked
5 + CN ms	= Processing interlocked
7330 Read 20.5 + CN ms	= TAU interlocked
7.7 + CN ms	= Processing interlocked
Write 20.3 + CN ms	= TAU interlocked
5 + CN ms	= Processing interlocked

Rewind
729 Models II and V = 1.2 minutes/reel
729 Model IV = .9 minutes/reel
7330 (High Speed) = 2.2 minutes/reel

Skip and Blank Tape
(add to subsequent write time)
729 Models II and V = 40.5 ms
729 Model IV = 27 ms
7330 = 103 ms

Backspace (after Read)
729 Models II and V = 46 + CN ms
729 Model IV = 33 + CN ms
7330 = 428 + CN ms

Backspace (after Write)
729 Models II and V = 52 + CN ms
729 Model IV = 37 + CN ms
7330 = 435 + CN ms

SYSTEM TIMINGS

Key to abbreviations used in formulas

L_A = Length of the A-field
L_B = Length of the B-field
L_C = Length of Multiplicand field
L_I = Length of Instruction
L_M = Length of Multiplier field
L_Q = Length of Quotient field
L_R = Length of Divisor field
L_S = Number of significant digits in Divisor (Excludes high-order 0's and blanks)
Length of A- or B-field, whichever is shorter
L_W = Number of characters to be cleared
L_X = Number of characters back to right-most "0" in control field
L_Y = Number of 0's inserted in a field
L_Z = Number of 0's inserted in a field
I/O = Timing for Input or Output cycle
F_m = Forms movement times. Allow 20 ms for first space, plus 5 ms for each additional space
T_m = Tape movement times
Σ = Number of fields included in an operation

OPERATION	OP CODE	FORMULA
Add (no recomplement)	A	$.0115 (L_I + 3 + L_A + L_B)$
Add (recomplement)	A	$.0115 (L_I + 3 + L_A + 4 L_B)$
Branch	B	$.0115 (L_I + 1)$
Branch if Bit Equal*	W	$.0115 (L_I + 2)$
Branch if Character Equal	B	$.0115 (L_I + 2)$
Branch if Indicator On	B	$.0115 (L_I + 1)$
Branch if Word Mark and/or Zone	V	$.0115 (L_I + 2)$
Clear Storage	/	$.0115 (L_I + 1 + L_X)$
Clear Word Mark	☐	$.0115 (L_I + 3)$
Compare	C	$.0115 (L_I + 1 + L_A + L_B)$
Control Carriage	F	$.0115 (L_I + 1) + F_m$
Control Unit	U	$.0115 (L_I + 1) + T_m$
Divide (aver.)*	%	$.0115 (L_I + 2 + 7 L_R L_Q + 8 L_Q)$
Halt	.	$.0115 (L_I + 1)$
Load Characters to A Word Mark	L	$.0115 (L_I + 1 + 2 L_A)$
Modify Address*	#	$.0115 (L_I + 7 or 9)$
Move Characters to A or B Word Mark	M	$.0115 (L_I + 1 + 2 L_W)$
Move Characters and Edit	E	$.0115 (L_I + 1 + L_A + L_B + L_Y)$
Move Characters to Record or Word Mark*	P	$.0115 (L_I + 1 + 2 L_A)$
Move Numeric	D	$.0115 (L_I + 3)$
Move Zone	Y	$.0115 (L_I + 3)$
Suppress Zeros	Z	$.0115 (L_I + 1 + 3 L_A)$
Move and Insert Zeros*	X	$.0115 (L_I + 1 + 2 \Sigma L_A + \Sigma L_Z)$
Multiply (aver.)*	@	$.0115 (L_I + 3 + 2 L_C + 5 L_C L_M + 7 L_M)$
No Operation	N	$.0115 (L_I + 1)$

* Special Feature

INPUT-OUTPUT CODES

OPERATION CODE	FUNCTION	MNEMONIC	BCD CODE	CARD CODE
1	Read a Card	R	1	1
2	Write a Line	W	2	2
2□	Write Word Marks		□ is modifier	is modifier
3	Write-Read	WR	C21	3
4	Punch a Card	P	4	4
4R	Read-Punch Feed*		R is modifier	R is modifier
4(I)R	Read-Punch Feed and Branch*		R is modifier	R is modifier
5	Read-Punch	RP	C41	5
6	Write-Punch	WP	C42	6
6R	Write-Read Punch Feed*		R is modifier	R is modifier
6(I)R	Write-Read Punch Feed and Branch*		R is modifier	R is modifier
7	Write-Read-Punch	WRP	421	7
8	Start Read Feed*	SRF	8	8
9	Start Punch Feed*	SPF	C81	9

ARITHMETIC CODES

OPERATION CODE	FUNCTION	MNEMONIC	BCD CODE	CARD CODE
A	Add	A	BA1	12-1
S	Subtract	S	CA2	0-2
?	Zero and Add	ZA	CBA82	12-0
!	Zero and Subtract	ZS	B82	11-0
@	Multiply*	M	C84	4-8
%	Divide*	D	A84	0-4-8

LOGIC OPERATION CODES

OPERATION CODE	FUNCTION	MNEMONIC	BCD CODE	CARD CODE
B(I)	Branch	B	BA2	12-2
B(I)d	Branch if Indicator ON		d is modifier	d is modifier
B(I)(B)d	Branch if Character is Equal		Contents of B compared to d	
V(I)(B)d	Branch if WM and/or Zone	BWZ	A41	0-5

MOVE AND LOAD CODES

OPERATION CODE	FUNCTION	MNEMONIC	BCD CODE	CARD CODE
D	Move Numerical	MN	BA4	12-4
L	Load Character to A Word Mark	LCA	B21	11-3
M	Move Characters to A or B Word Mark	MCW	CB4	11-4
Y	Move Zone	MZ	CA8	0-8
Z	Move Characters and Suppress Zeros	MCS	A81	0-9
	Set Word Mark	SW	CA821	0-3-8
□	Clear Word Mark	CW	CBA84	12-4-8

MISCELLANEOUS OPERATION CODES

OPERATION CODE	FUNCTION	MNEMONIC	BCD CODE	CARD CODE
C	Compare	C	CBA21	12-3
E	Move Characters and Edit	MCE	CBA41	12-5
F	Control Carriage	CC	CBA42	12-6
H	Store B-Address Register*	SBR	BA8	12-8
K	Select Stacker	SS	CB2	11-2
N	No Operation	NOP	B41	11-5
Q	Store A-Address Register*	SAR	CB8	11-8
/	Clear Storage	CS	CA1	0-1
.	Halt	H	BA821	12-3-8
#	Modify Address*	MA	821	3-8

CHARACTER AT d FOR B(I)d BRANCH

d	BRANCH ON	d	BRANCH ON
b1	Unconditional	R	Carriage Busy*
9	Carr. Chan. #9	T	Low Compare B $<$ A*
A	"Last Card" Switch	U	High Compare B $>$ A*
B	Sense Switch B*	Z	Overflow
C	Sense Switch C*	?	Reader Error if I/O Check Stop Switch OFF
D	Sense Switch D*	!	Punch Error if I/O Check Stop Switch OFF
E	Sense Switch E*	⧧	Printer Error if I/O Check Stop Switch OFF
F	Sense Switch F*	@	Carr. Chan. #12
G	Sense Switch G*	%	Processing Check with Process Check Switch OFF
K	End of Reel*	/	Unequal Compare B $\neq$ A
L	Tape Error*		
S	Equal Compare B = A*		
P	Printer Busy*		

CHARACTER AT d FOR MAGNETIC TAPE

d	OPERATION
B	Backspace Tape Record
E	Skip and Blank Tape
M	Write Tape Mark
R	Rewind Tape
U	Rewind Tape and Unload

CHARACTER AT d FOR DISK STORAGE

d	BRANCH ON
N	Access Inoperable
V	Read/Write Parity Check or Read Back Check Error
W	Wrong-Length Record
X	Unequal Address Compare
Y	Any Disk Storage Error Condition

CHARACTER AT d FOR 1407 CONSOLE INQUIRY STATION

d	
Q	Inquiry Request
*	Inquiry Clear

MAGNETIC TAPE %UX TAPE UNIT ADDRESS

INSTRUCTION	FUNCTION	MNEMONIC	BCD CODE	CARD CODE	REMARKS
L(%UX)(B)d	Read/Write Tape with Word Marks	LCA			d-modifier, R-Read Tape
M(%UX)(B)d	Read/Write Tape	MCW			W-Write Tape
M(%CX)(B)R	Read Compressed Tape*				(%CX) is address of tape unit
P(A)(B)	Move Characters to Record or Group Mark*	MCM	CB421	11-7	
U(%UX)d	Control Unit	CU	CA4	0-4	
X(A)(B)	Move and Insert Zeros*	MIZ	CA421	0-7	

COLUMN BINARY

INSTRUCTION	FUNCTION	REMARKS
1C	Read Column Binary	C is Modifier
4C	Punch Column Binary	C is Modifier
M(A)(B)A	Move and Binary Decode	A is Modifier
M(A)(B)B	Move Binary Code	B is Modifier
M(%BX)(A)R	Read Binary Tape	%BX is Address of tape unit
M(%BX)(A)W	Write Binary Tape	
W(I)(B)d	Branch if Bit Equal	BBE is mnemonic

DISK STORAGE %FX DISK OPERATION

INSTRUCTION	FUNCTION	REMARKS
M(%F0)(B)R	Seek Disk	B is Disk Address
M(%FX)(B)R	Read Disk	X can be 1, 2, or 3
M(%FX)(B)W	Write Disk	1 Specifies Single Record
L(%FX)(B)R	Read Disk with Word Marks	2 Specifies Full Track
L(%FX)(B)W	Write Disk with Word Marks	3 Specifies a Write Disk Check operation M(%F3)(B)W

1407 INQUIRY %TO ADDRESS

INSTRUCTION	FUNCTION	REMARKS
M(%TO)(B)R	Read Console Printer	Data from 1407 transferred to B-address
M(%TO)(B)W	Write Console Printer	Data at B-address transferred to 1407
L(%TO)(B)R	Read Console Printer with Word Marks	Data from 1407 transferred to B-address with Word Marks
L(%TO)(B)W	Write Console Printer with Word Marks	Data at B-address transferred to 1407 with Word Marks
M(%TO)(B)W	Line Space	B is address of a Group Mark with a Word Mark

* Special Feature